NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT

MAF

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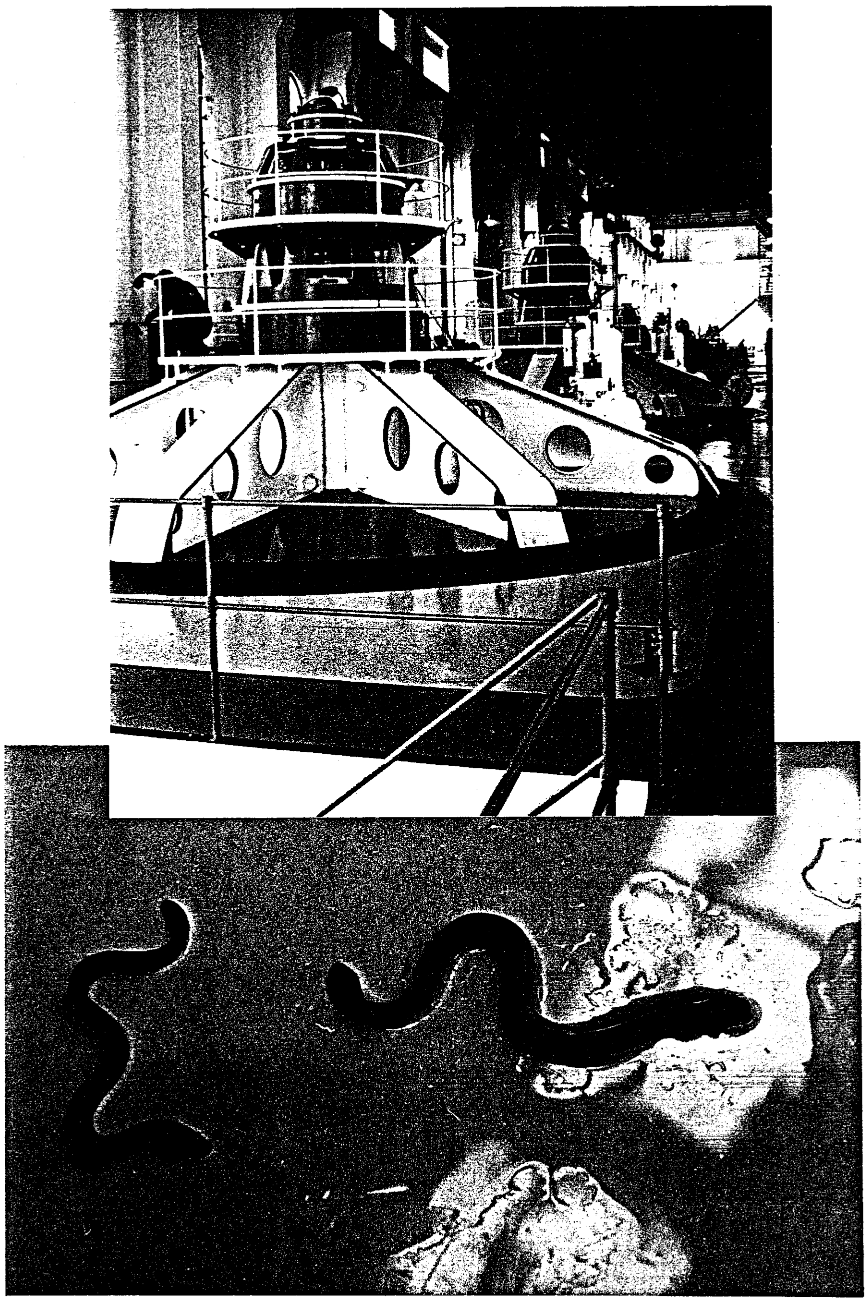

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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

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INTRODUCTION

Ngai Tahu, as tangata whenua, have asked Electricorp to install fish passes over the Waitaki Dams. These dams act as a total barrier to the upstream movement of native fishes. This report lists options for fish passes over the middle Waitaki dams.

A series of potential fish pass routes over Waitaki, Aviemore and Benmore dams were identified during a three day site visit. The next step is engineering input into evaluation, plans and specifications to examine the feasibility and cost of different routes. Only then can a decision be made on which options to build.

The hydroelectric dams across the Waitaki have had a considerable impact upon migratory native fishes. Only eels, with their remarkable longevity (up to 100 years of age), and the tenacity with which their young (elvers) migrate, remain upstream. Waitaki Dam is lower, and there are occasional opportunities for elvers to get past. In contrast, Aviemore and Benmore are total barriers. Now the decline in eels upstream of these dams is obvious. Ngai Tahu have asked Electricorp to install elver passes over all the dams.

Eels are very widely distributed in New Zealand. The longfinned eel (*Anguilla dieffenbachi*) penetrates well inland and is the top predator in our fresh waters. Longfinned eels grow to a great size and can live for many years before migrating back to the sea to spawn. This fish was, and remains, a valued resource. It was a major source of protein and fats for the inland Maori. Now it also supports a valuable commercial fishery.

Many of the native fishes have a similar life cycle to eels. Most native fish fauna migrate to and from the sea and for some, this migration is obligatory. Hydroelectric dams form formidable obstacles for native fishes, in many cases their populations upstream diminish or die out altogether. Migratory native fish would benefit from well designed fish passes.

Good fish pass design exploits the behaviour and biology of the fish. The next section outlines the relevant biology of the major species.

ELVERS

Elvers are remarkable creatures. They have already swum an incredible distance before their effort is reduced to futility by the Waitaki Dams. No one knows where eels breed but it is presumed to be somewhere deep in the tropical Pacific Ocean. From there the larvae travel back to New Zealand. Over the continental shelf there is a metamorphosis into miniature eels (or elvers). Once into freshwater they darken and begin their migration upstream. Elvers usually hide among the gravel and stones of the river bed during the day. At night they emerge and continue their migration. Summer is the peak period of migration, upstream movement begins in spring in the estuary and continues until March at upstream sites.

Elvers respond to water velocities as low as 0.04 $m.s.^{-1}$ and exploit boundary layers, eddies and backwaters to ease their passage upstream. They can swim against velocities up to 0.34 $m.s.^{-1}$, but velocities greater than 1.0 $m.s.^{-1}$ cannot be resisted for more than 30 sec. The behaviour of elvers when they meet higher water velocities can be used to design successful elver passes.

At the base of a hydro dam the major flow is through the draft tubes. Elvers swim to this point and accumulate where the water velocity blocks further progress. Their migratory instinct then compels them to try and climb past the obstacle. At natural waterfalls and rapids there are almost always marginal areas wetted by splash, plus numerous side trickles and seepages where elvers can climb. Elvers below hydro dams also seek out seepages and minor discharges and attempt to climb at these points. We can exploit this behaviour for elver passes. Other native fishes also show this climbing behaviour and can benefit from an elver pass.

PRINCIPLES OF FISH PASS DESIGN

There are three key points for a successful fish pass:

1. THE ENTRANCE. Where fish find the fish pass.
2. THE BODY OF THE PASS. Where fish traverse the obstacle.
3. THE EXIT. Where fish are returned.

The basic principles of fish pass design and the features of the various designs been covered in previous reports to Electricorp. We have used two designs for climbing native fish:

Pipe and brush elver passes use nylon brushes, like giant bottle brushes, pushed inside smooth pipe (usually plastic pipe). The aggregate-coated fish pass uses plastic pipe coated on the interior with aggregate bonded by solvent based plastic cement.

The aggregate-coated fish pass is cheaper per unit length than the pipe and brush pass and may require less maintenance. It is very effective at passing elvers and other native fish but suffers from the disadvantage that only inclined sections (up to at least 50^0) will work. In contrast the brush type elver pass will pass elvers up vertical slopes, but cannot be used by other native fish.

In both designs, water is only trickled down the pipes and so water use is low. Horizontal sections of both designs need nothing but smooth pipe. The fishes swim in the shallow stream flowing in the bottom of the pipe.

The major cause of fish pass failure (Fig 1) is poor entrance design. Unless fish can locate the entrance even the best design is doomed to failure. Fish pass experts consider that 12-15% of the flow should be allocated to a fish pass so that fish can find the entrance. For the fish pass designs we are contemplating here, only about 10^{-6} of the flow will be allocated and entrance location is critical.

The priority is to locate those structural and hydraulic features at the dam bases where elvers already accumulate. These points are the entrance sites. The remainder of the elver pass has to be designed around these points because without elvers there is no elver pass.

The dams were visited at night, on the new moon, in February. The weather was warm, overcast and with occasional rain. Conditions were ideal for elver migration and accumulations were observed at Waitaki and Aviemore. Kelly Davis (Ngai Tahu) and Graeme Hughes (South Canterbury Fish and Game) contributed their observations of elver gathering points in past years. Kelly's long experience on the Waitaki was particularly useful at Benmore, where elvers no longer accumulate.

We can suggest potential layouts for fish passes starting from known accumulation points. In the next section of the report, the options for each dam are listed in order of priority and practicality. As the elvers are migrating upstream, naturally Waitaki Dam comes first.

FISH PASS OPTIONS

WAITAKI DAM

ENTRANCE SITING

The pattern of turbine operation will greatly effect the accumulation point of elvers below Waitaki Dam.
During this site visit, the two left side turbines were not operating. As a result, the elvers could swim into the draft tube bay, using slack water on the left side. Elvers were seen at night swimming around the sides of the draft tube bay and attempting to climb where the transformer cooling water discharges.

When the two left side turbines are in operation, elvers will find the sluice gate channels to the left of the auxiliary turbine discharge and the associated wingwall (Fig 2). But we found no elver accumulations as these turbines were shut down.

Elvers were attracted toward the main flow and could (just) swim along the draft tube side of the wingwall into the draft tube bay (Fig 2 & 3). When the turbines beside the wall are operated the resulting water velocity blocks elvers from the draft tube bay and they are deflected behind the wall. Their searching behaviour then leads them to the sluice channels.

The sluice channels form an excellent site for an elver pass (Fig 4 & 5). But there would need to be a deliberate policy of operating the turbines adjacent to the wall, at night, during the main elver migration period. With the turbines operating, elvers would be herded towards the sluice channels

OPTION ONE

Starting at the base of the sluice gates, fix a pipe and brush elver pass in each sluice shaft. These would rise vertically to the sluice gate winch platform. The pipes would pass through holes cut in the checker-plate covers and would then run horizontally across the dam to the upstream-left corner of the dam top. Both pipes would lead into a flushing box with facility for an electronic counter. From this point elvers would be flushed straight down into the lake via a pipe fixed to the dam wall.

All sections would be of ABS plastic pipe. Tees are fitted at the end of rises for maintenance checks and to permit insertion and removal of brushes. Push fit end caps can be secured on tees with selftapping stainless steel screws. Covers are needed on all exposed sections to resist mechanical damage and radiation. Covers also protect the elvers, solar heating of the pipe can raise temperatures above lethal levels.

A header tank and a self-priming pump could be sited at this far corner of the dam with minimal interference to other operations. The pump intake could be led down the back of the dam to rest inside the channels that carry the sluice gate stoplogs. Siting the pump intake inside the channel would protect it from damage during floods (Fig 6, Plan 1 & 2).

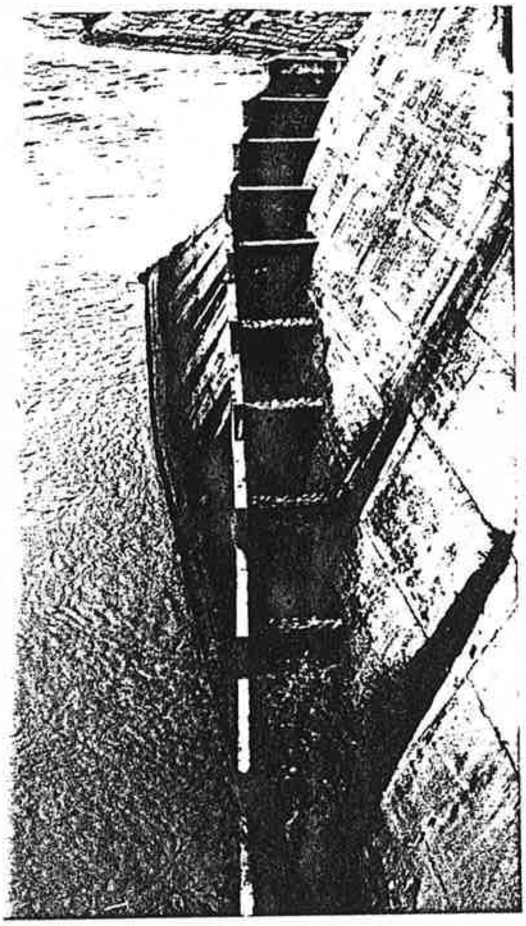


FIG 1

A CAUTION, FISH PASS DESIGN IS NOT EASY,
THE FAILED FISH LADDER AT WAITAKI DAM.

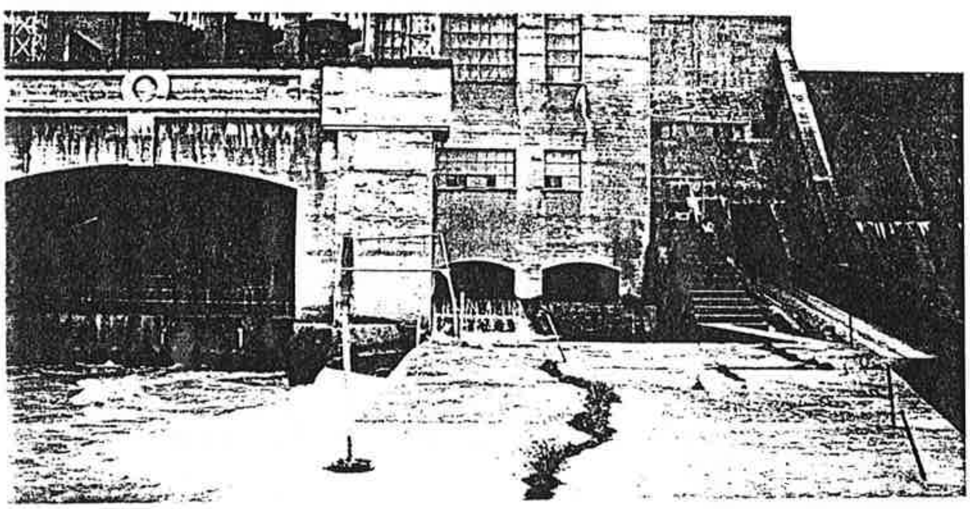


FIG 2

SLUICEWAY CHANNELS TO RIGHT, DRAFT TUBE BAY ON LEFT. DISCHARGE FROM AUXILLARY TURBINE CENTRE

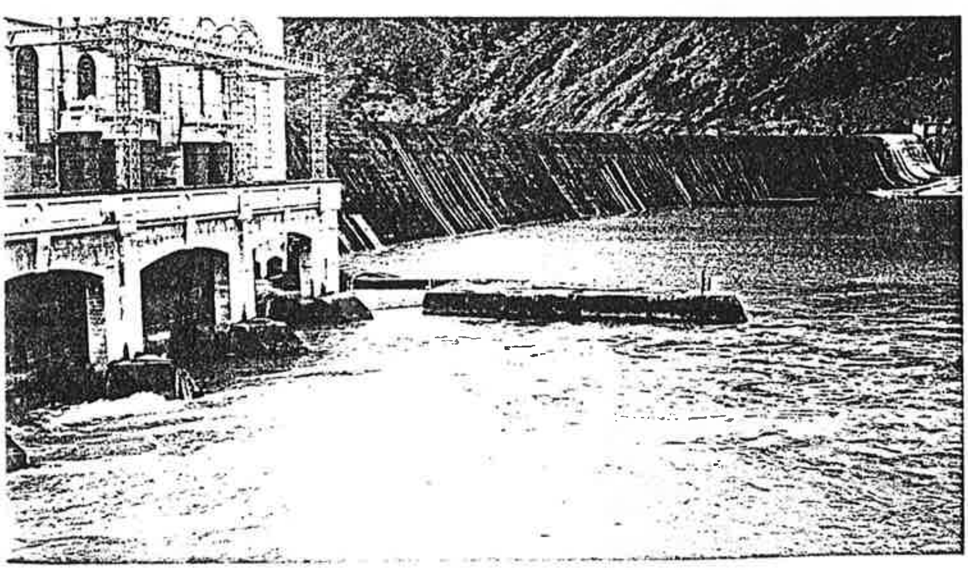


FIG 3

MAJOR DIFFICULTY FOR DIVERTING ELVERS TO THE SLUICEWAY CHANNELS - THE WING WALL (CENTRE).

WHEN ADJACENT TURBINES ARE NOT RUNNING (AS IN PHOTO) ELVERS FOLLOW FLOW INTO DRAFT TUBE BAY AND BECOME TRAPPED IN THAT AREA.

FIG 4 THE SLUICE CHANNELS, BOTH CHANNELS ARE USED BY ELVERS WHEN FLOW CONDITIONS ARE CORRECT. BOTH CHANNELS COULD BE MODIFIED INTO ELVER PASSES.

FIG 5 (TOP) INSIDE THE SLUICE CHANNEL SHOWING THE SLOPE UP WHICH ELVERS CLIMB FROM THE RIVER

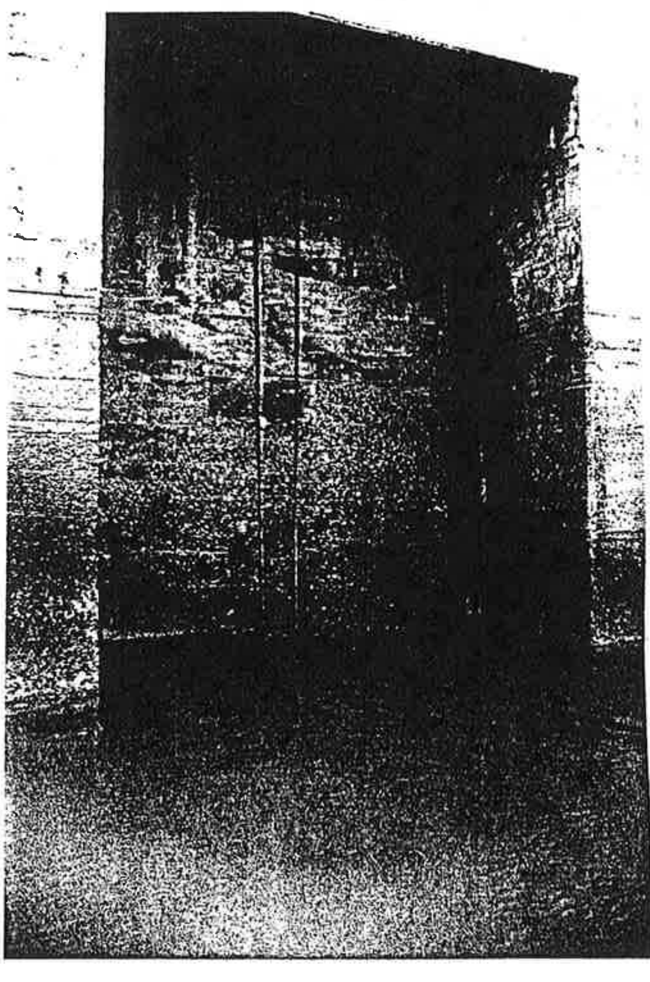
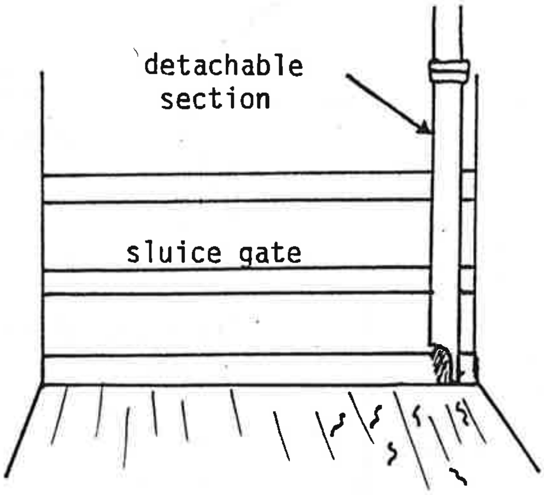
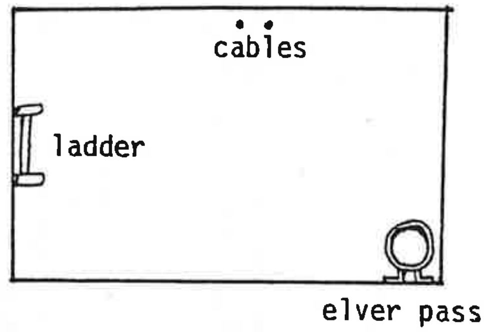


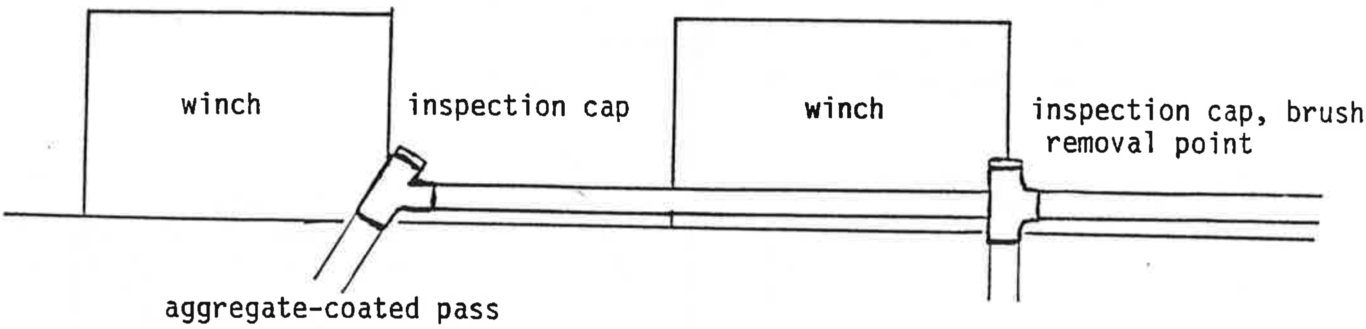
FIG 6 CHANNELS FOR THE SLUICE GATE STOPLOG THE PUMP INTAKE COULD BE SECURED TO ONE OF THE SIDE WALLS OF THE LEFT SIDE CHANNEL

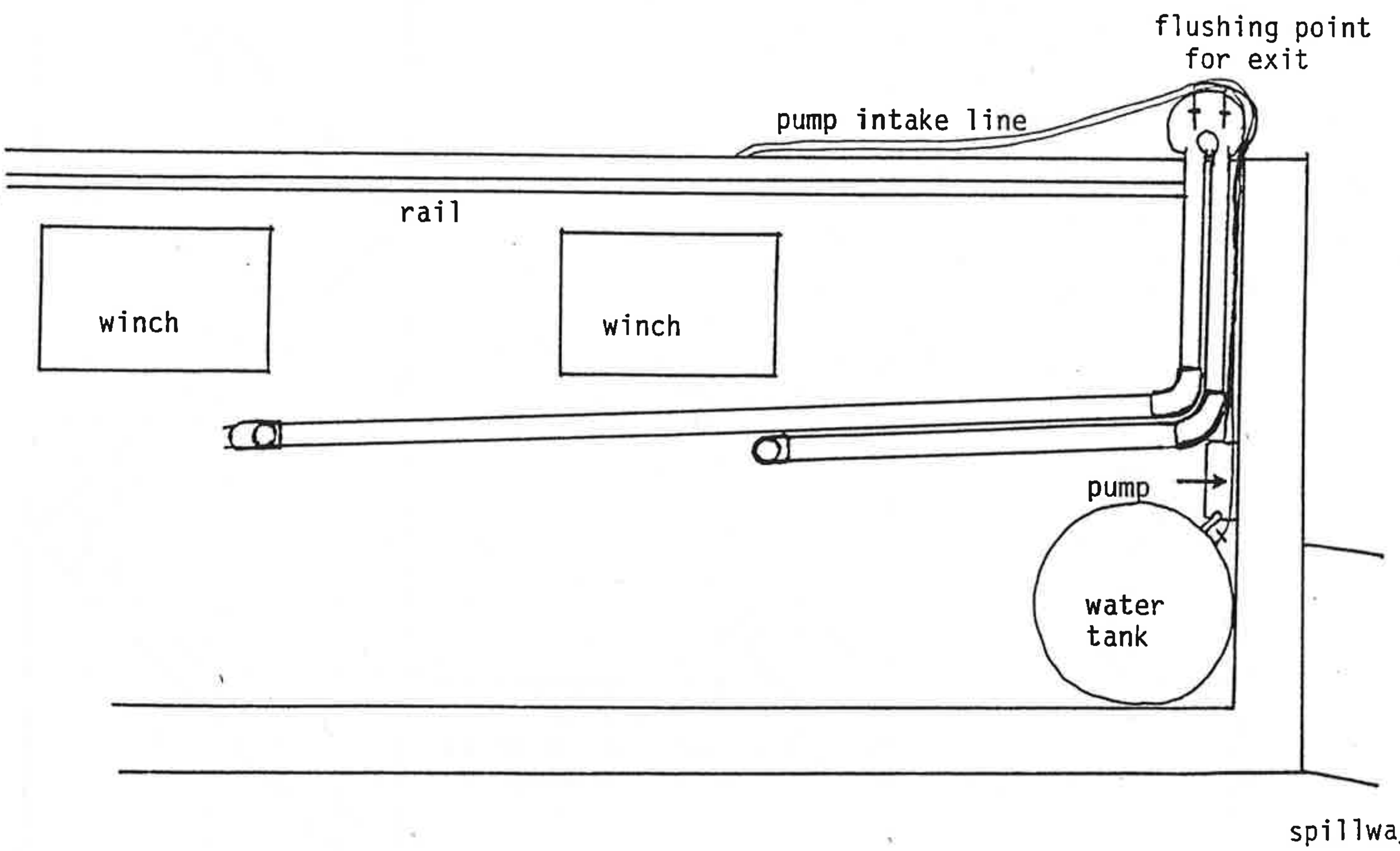


ENTRANCE TO PASS

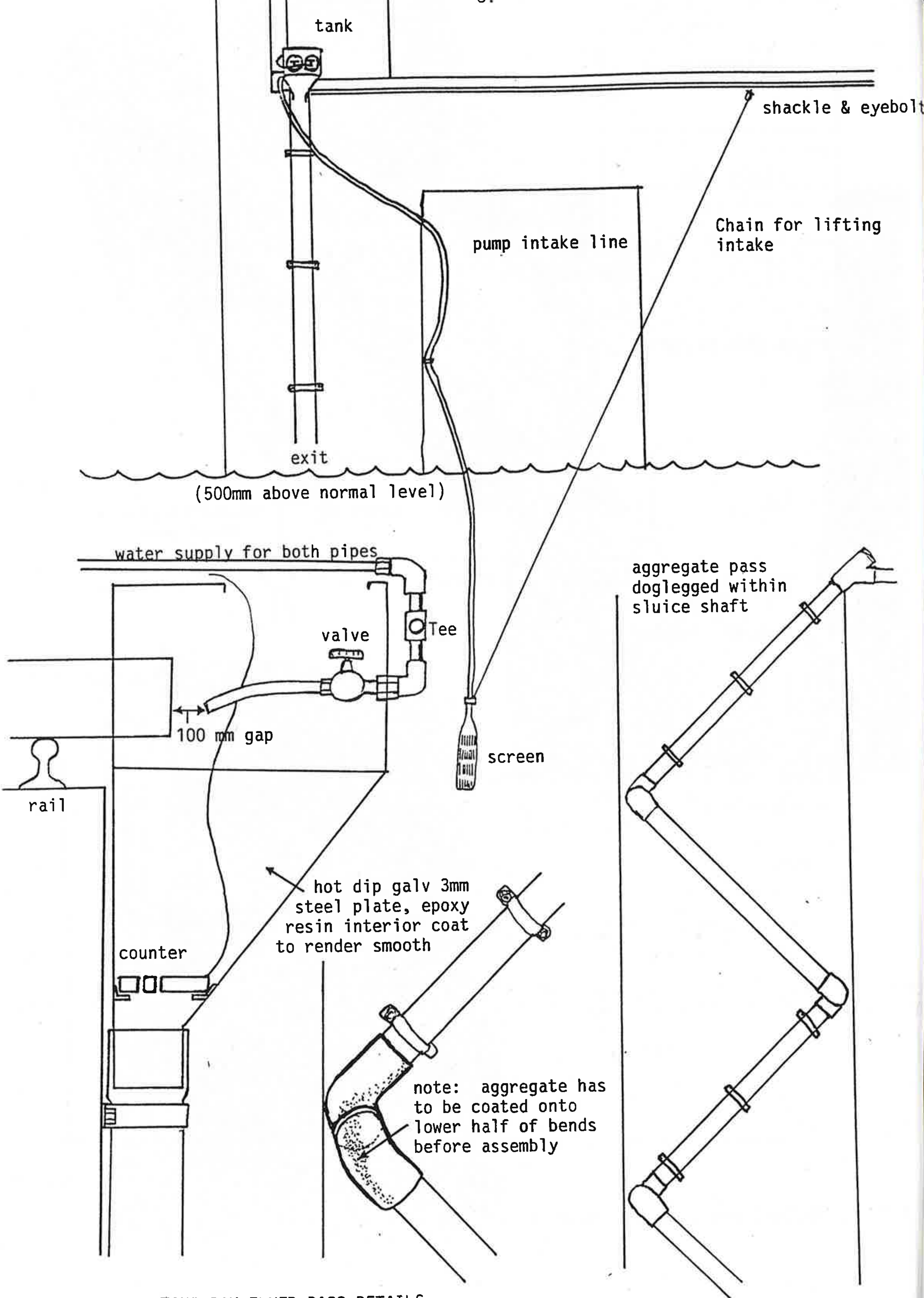


SITING IN SLUICE GATE SHAFT





PLAN 1. WAITAKI DAM ELVER PASS DETAILS



PLAN 2. WAITAKI DAM ELVER PASS DETAILS

There are several reasons why operation of the sluice gates would not be compromised:

1. Clearances with the sluice gate shafts are generous. There is at least 1.5 m between the gates and their actuating cables on the upstream side and the downstream wall of the shaft. An access ladder is already fixed to the side wall of each shaft and the pipe could easily be attached in the angle between the side and downstream walls.

2. The sluice gates are operated very infrequently, at intervals measured in decades. Provision can be made to have the lower 2-3 m of the elver pass detachable for when the sluices are to be opened.

3. Emergency operation of the sluice would not be affected by the elver pass. The lower section of the pass would simply be swept away. Low cost of the plastic pipe and brush design means that this is perfectly acceptable if provision for replacement is made.

OPTION TWO

The aggregate-pass design requires sloped pipe. Although this means that more material is needed to scale an obstacle, there are other advantages. More species can be passed and unit lengths are cheaper than the pipe and brush design.

Within the confines of the sluice gate shaft a sloping pipe could be doglegged up the downstream face of the shaft (Plan 2). Material and installation costs are greater but there may be considerable environmental benefits.

It would be very interesting to see whether the present paucity of native fishes, other than eels, below Waitaki Dam altered after such a pass was installed. I suggest an aggregate fish pass be installed in the shaft nearest the powerhouse and a vertical pipe and brush pass installed in the second shaft.

OPTION THREE

For many years water trickled down the spillway against the left bank abutment. K. Davis (pers. comm.) saw elvers climbing here (Fig 7) about ten years ago. We reached this point using a boat provided by South Canterbury Fish and Game. Wave action down the lake has now created a beach in this corner of the spillway (Fig 8) and sealed the leak.

Water pumped down the spillway would recreate the trickle and encourage elvers to climb (electricity is available at the site).

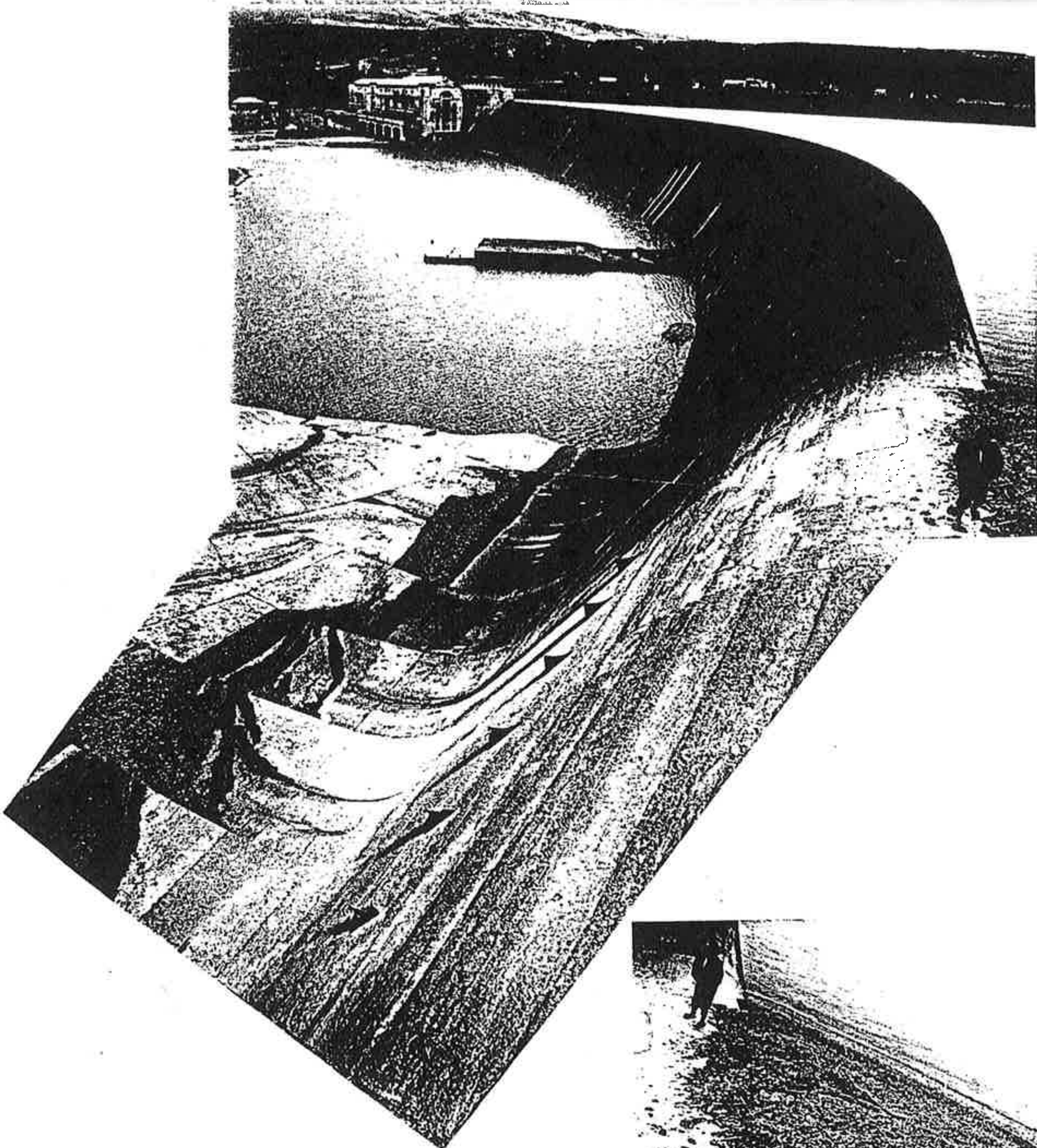


FIG 7 TRUE LEFT BANK OF THE WAITAKI SHOWING WEIR CREST WHERE ELVERS USED TO CLIMB.

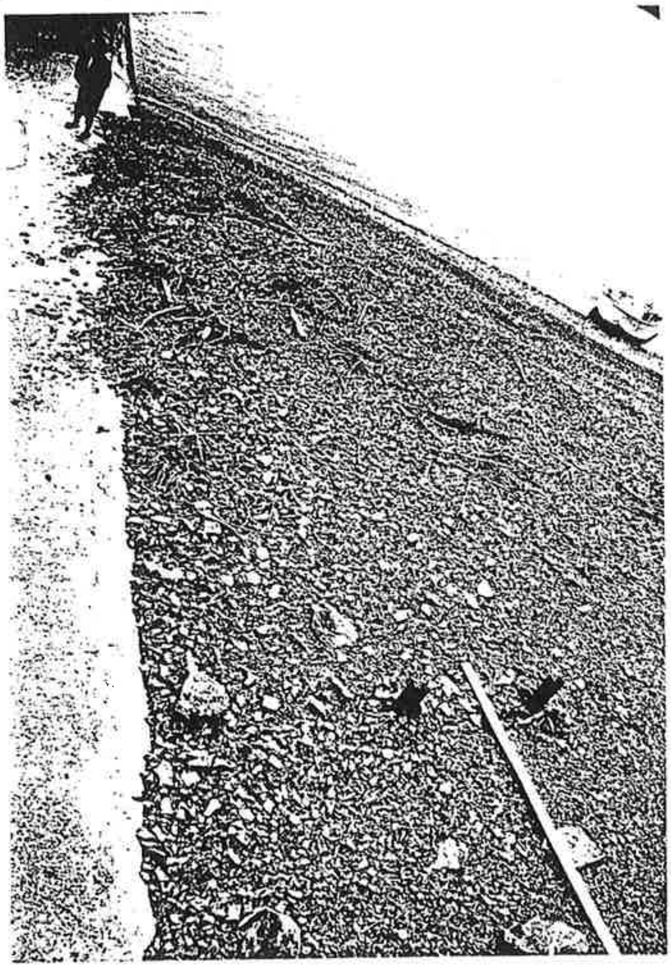


FIG 8 BEACH FORMED IN DAM CORNER, A FLUME WOULD BE NEEDED TO CARRY ELVERS BACK TO THE LAKE.

An exit flume is needed running down the back face of the spillway, across the beach, to the lake. The flume should be securely anchored as wave action and floods can overtop the spillway. The pump-intake line should be secured beneath the flume. The intake could be sited within the beach gravels. One problem with this option is predation. Elvers climbing the spillway face have no protection from birds and rodents.

OPTION FOUR

A stormwater drain discharges into the right bank of the draft tube bay. The drain channel leads to the back of the powerhouse. A sloped native fish pass could be led from here up to the dam crest as a single diagonal. From here a horizontal pipe over the

dam is needed. The route for this pipe is not immediately clear. There may be passages through the dam. Alternatively the pipe could be led right around to the exit point for OPTION 1 and 2.

AVIEMORE DAM

ENTRANCE SITING

At night elvers were seen climbing at the sides of the weirs in the lower, fish pass section, of the spawning channel (Fig 9). Electric fishing surveys of the spawning channel have shown that few eels reside in the channel (G. Hughes pers comm). But the entrance siting, immediately beside the draft tube discharge, certainly attracts elvers. The auxiliary turbine is the primary water supply for the spawning channel. When it is shut down considerable numbers of elvers move through the outlet pipe into the powerhouse. In the past Kelly Davis had also seen elvers climbing on the left bank spillway wingwall extension. They were attracted to a pipe discharging seepage water from the dam inspection galleries.

OPTION ONE

An elver accumulation point could be created in the spawning channel by fixing 50-100 mm wide, polished stainless steel lips to the sides of the lowest weir (Fig 10). This modification would have no effect on salmon and trout passage up the spawning channel but would create flow conditions impassable to elvers. A fish pass could start immediately below the weir.

Aggregate coated pipe, fixed to the right hand side wall of the channel, can be angled back to intersect with the wall of the powerhouse. There are two clear spans in this straight run of pipe, one over the spawning channel entrance and the other between the channel wall and the dam. A "cable tray" type supporting structure is needed for these spans. From where the pipe meets the powerhouse a gentle slope can be run up to meet the ledge extending out over the draft tube bays (Plan 3). The ledge forms a flat horizontal surface suitable for fixing a plain pipe swimming section, right across the front of the powerhouse. The pipe can then return along the right spillway wingwall extension to the back of the powerhouse. From this point an aggregate-coated pipe is required. Support is necessary across the gap between the powerhouse and the spillway wingwall. Inclining the pipe at this point, up to 45^0, increases the length and costs of the support structure. But it works toward lowering the slopes needed for the ensuing stage (Fig 11). The pipe is then fixed to the outside face of the right spillway wing wall and climbs up to the flat face immediately behind the spillway gate. From here the pipe can travel around the corner to exit into the dam behind the spillway gates (Fig 12).

The pump and reservoir can be sited on the damcrest above the gates. Drainholes through cable ducts in this area allow access for the pump intake and water supply lines. Fixing the pump intake line beneath the roadway over the spillway allows the intake to be sited beside the dam on the right side of the spillway. Allowing removal for cleaning or flood conditions is then a simple matter (Plan 4).

OPTION TWO

There is a vertical shaft in the dam crest immediately behind the left end of the powerhouse. This shaft is unused, a drainage pipe at the bottom leads toward the powerhouse, probably to the pump sump (Fig 12). Provided flows were adequate to maintain dissolved oxygen levels, a waterfilled pipe could be linked with the swimming section around the powerhouse (OPTION ONE) to extend partway up this shaft. From here a brush type elver pass or perhaps a doglegged aggregate-pass could rise to the top of the dam. Access to the lake from the top of the shaft was not immediately obvious.

Advantages of the shaft over the wing wall are:

> Protection from solar heating, radiation damage to plastics and problems for vandals (although vandals would need determination with either option). But the wingwall offers an easier slope for a climbing pass and requires a less complex structure. The water filled section of pipe would also need to be strong enough to take the pressure.

I have a major concern about the use of the spawning channel as the entrance for an elver pass. I understand that as part of the automation of Aviemore, the auxiliary turbine will be permanently shutdown. If this is the case then the water used to run the spawning channel (0.63 cumecs), will no longer be generating electricity. Will Electricorp be content to run this water to waste? Will the spawning channel only be operated during the spawning season? We need to know what is going to happen to the spawning channel and the water supply, before deciding upon this entrance site for the elver pass.

OPTION THREE

Elvers congregate beneath the drain on the left spillway wingwall extension. This drain discharges water from the access tunnels. This point is definitely unsuitable for an elver pass entrance as any structure would be destroyed when the spillway was opened.

However, there is a sheltered spot downstream where the wingwall extension ends (Fig 12). If the discharge point was changed by laying a concrete channel from the access tunnel drains to the end of the wingwall, then a new elver accumulation point would form. A small stainless steel weir on the final slope could block elvers from using this drain. Instead they would be offered a brush type elver pass to the level behind the wingwall extension. A plain horizontal pipe through which the elvers could swim can then easily lead them to the base of the wingwall. From here a aggregate-pass could be angled up the left spillway wingwall as a mirror image of OPTION ONE (Fig 13). The pass would return around the flat face behind the spillway gates to discharge into the dam. A pump and supply tank could be located beside the spillway winch machinery. Alternatively OPTION THREE could share a common water supply with OPTION ONE.

An exit close to the rock of the left bank may be desirable. The natural rock surface would offer the elvers cover from predation. It is easy to imagine large brown trout cruising beneath the elver pass exits, waiting to dine on fresh, dazed elvers.

Bearing potential predators in mind, the OPTION ONE pipe from the right bank could run beneath the roadway <u>right</u> across the spillway bays, to join a common exit close to the left bank.

OPTION FOUR

The old sewage treatment ponds for Aviemore village form a linked series of ponds rising most of the height of the dam (Fig 14 & 15). The system is further extended by a stormwater drain ending in the true right corner of the earthen dam. Obviously extreme caution is needed when considering a permanent water supply in this area.

A well engineered concrete flume channel running from above the lake, under the road and along the stormwater drain is needed. Problems include the 12Kv earth return line and doubtless other services which run through this area.

A further problem is two 3 m drops at the outlet of each treatment pond. Passage would be facilitated by constructing artificial rapids to allow elvers to scale these drops. These can be made by dumping rock rubble and then grouting (Fig 16).

Finally, this artificial stream channel would be diverted into the spawning channel and elver access over the weirs in the fishpass section improved. Each weir could be roughened at the sides by resting narrow gabion mesh baskets in the downstream corners. Power, pump and intake siting and the exit structure into the lake need further consideration.

BENMORE DAM

Benmore is a daunting structure (Fig 17). However one option, apart from sheer size, seems straight forward.

ENTRANCE SITING

No elvers have been seen at the base of Benmore for many years. Kelly Davis used to see elvers congregating at the base of the generator cooling water discharge (Fig 18). The route for a climbing fish pass would thus begin at this point about 1 m upstream of the slope inflexion (Fig 19).

OPTION ONE

The pass would start at the cooling water discharge. Kelly described watching elvers climb in the angle between the wall and the slope. It would be easy to channel them into a pipe radiused with grout to this angle. After a short horizontal section to give a easy start to the pass, aggregate coated pipe would angle up to the side of the tunnel carrying the generator cooling water (Fig 20). Heavy gauge stainless steel mesh over the pass entrance, but not fixed at the bottom, will exclude rats without blocking elvers.

The pipe could then run at a constant angle to the back of the powerhouse. A stilling chamber continues the tunnel on under the access road.

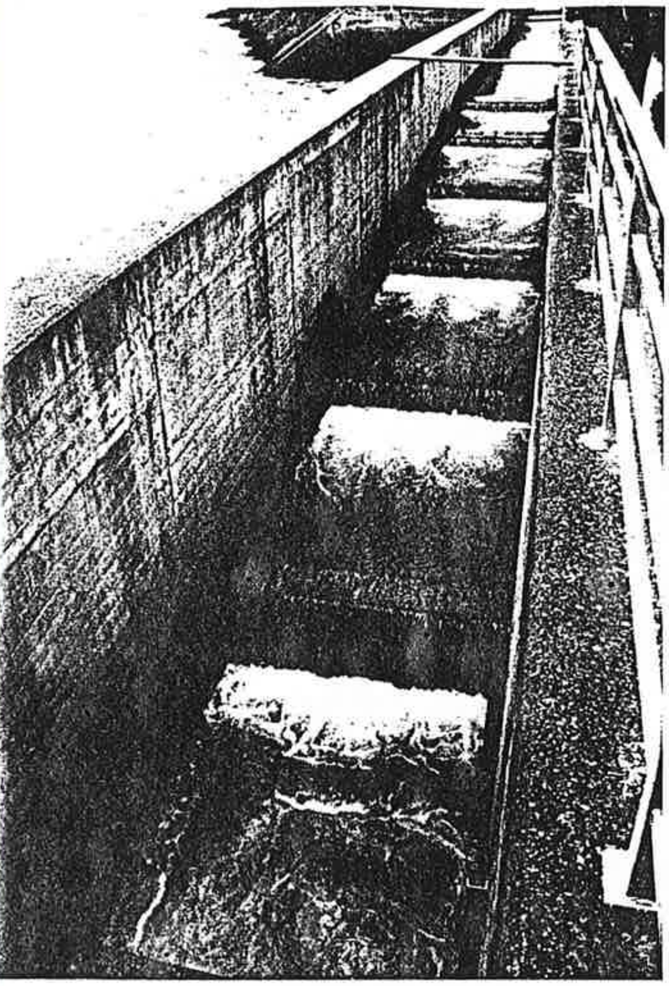


FIG 9

THE FISH LADDER LEADING TO THE AVIEMORE SPAWNING CHANNEL. ELVERS CLIMB THE WETTED CONCRETE ON THE WALL BESIDE EACH WEIR.

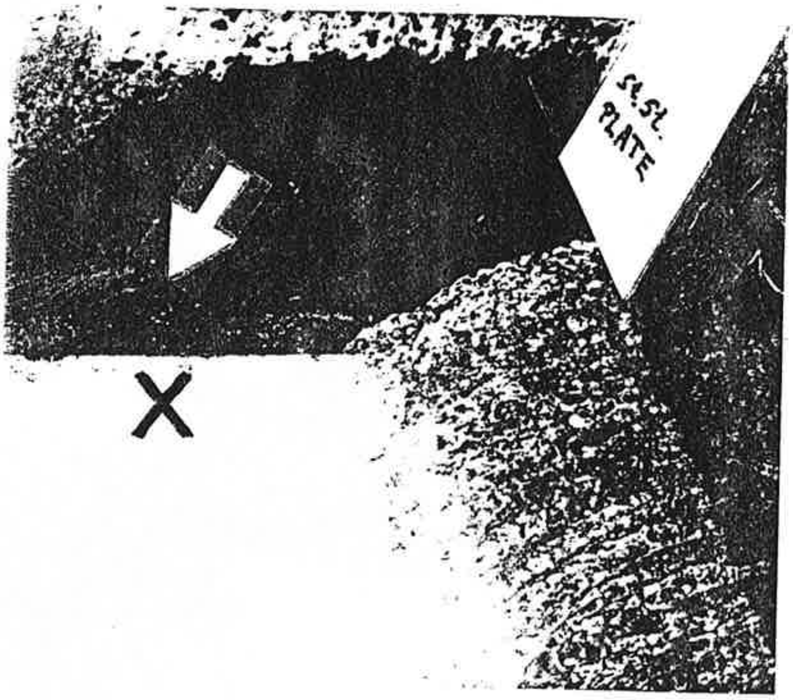


FIG 10 (TOP)

ELVERS CLIMBING WETTED CONCRETE, A SMOOTH FACE (STAINLESS STEEL) AS MARKED WOULD BLOCK THEIR MOVEMENT. THE POINT FOR A SIGH PASS ENTRANCE IS THEN OBVIOUS (X)

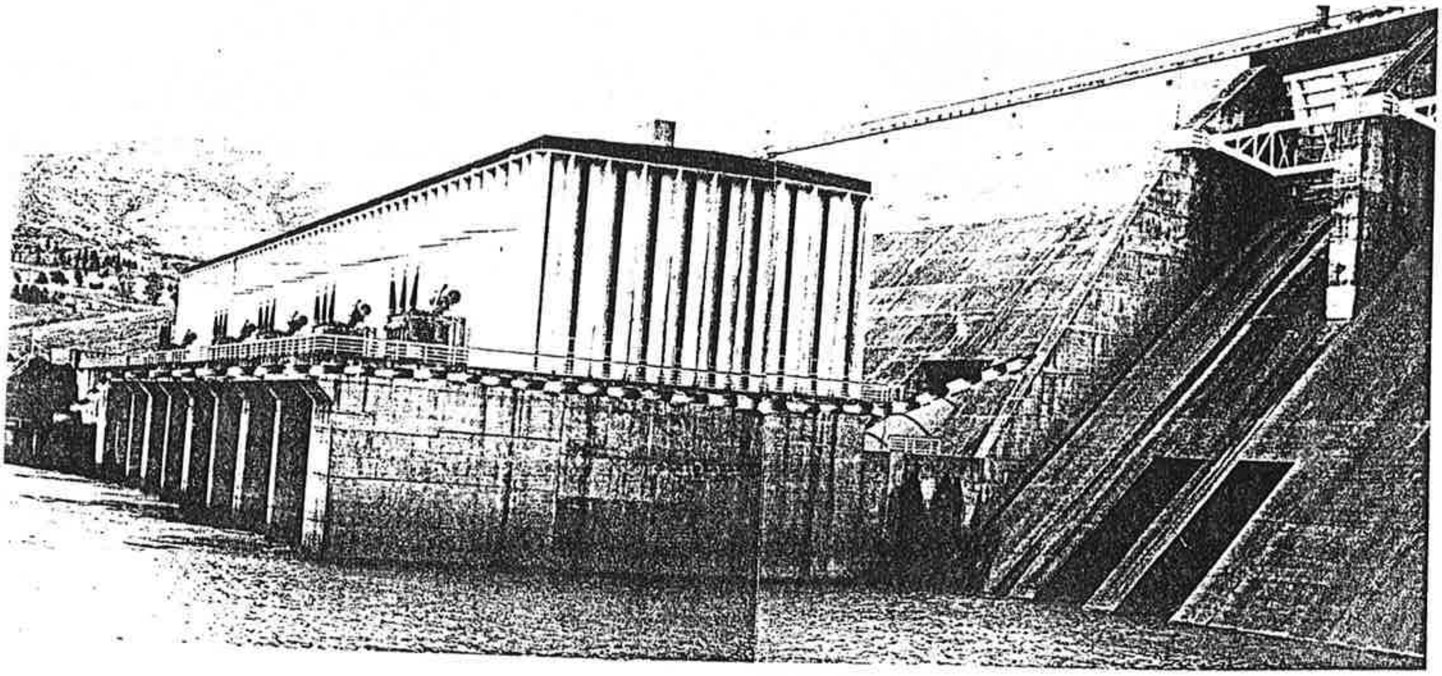


FIG 11 ROUTE FOR ELVER PASS FROM SPAWNING CHANNEL (LEFT) AROUND POWER HOUSE TO RIGHT SPILLWAY WINGWALL.

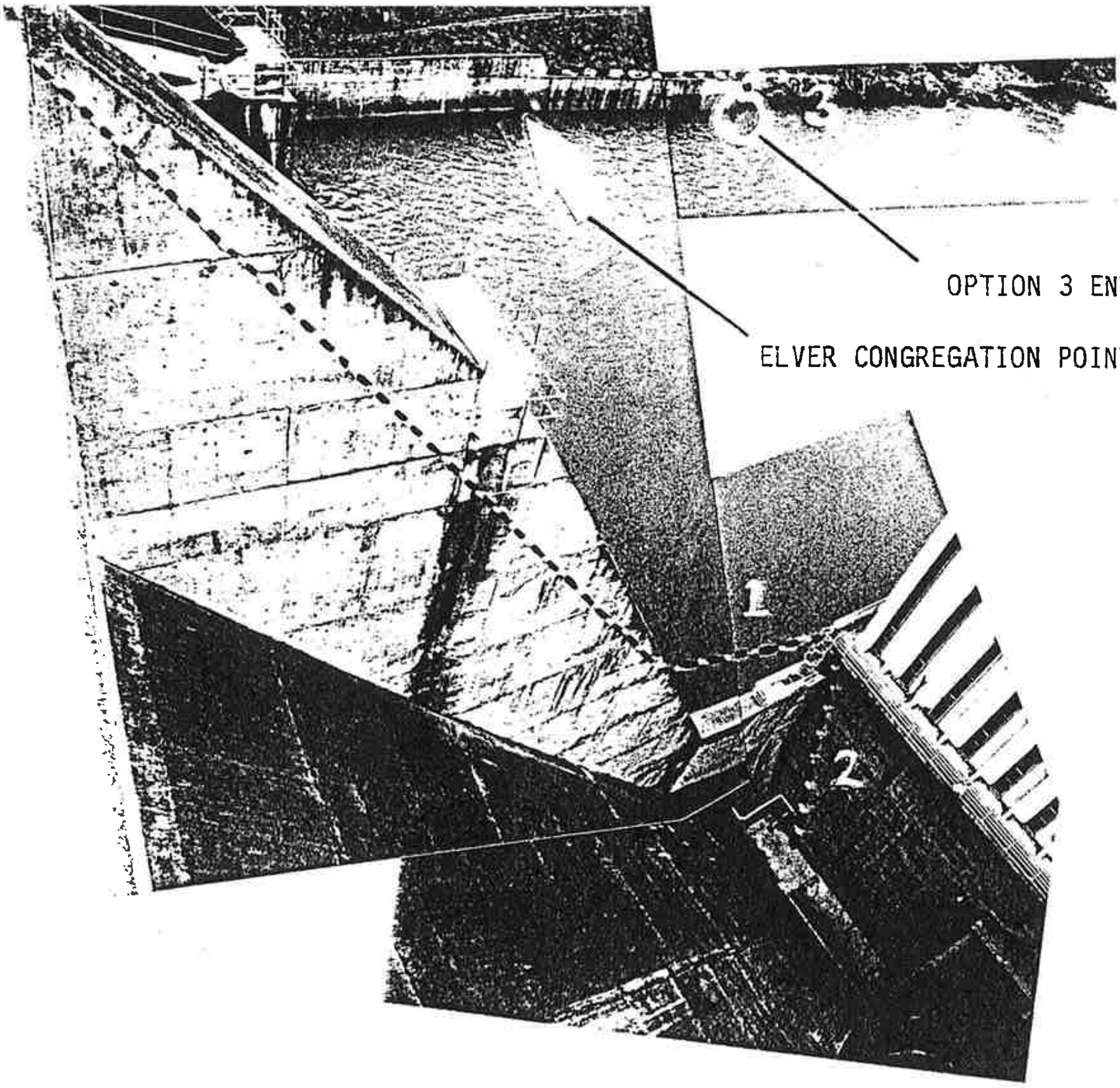


FIG 12 (TOP) ELVER PASS ROUTES AT AVIEMO

OPTION 1. FROM POWERHOUSE CORNER UP SIDE OF RIGHT SPILLWAY WING WALL.

OPTION 2. VERTICAL SHAFT, ACCESS MAY BE UNDE COVER AT THE BASE OF THE POWER HOUSE.

OPTION 3. ENTRANCE BEHIND LEFT SPILLWAY WINGWALL EXTENSION, ARROW SHOWS ELVER CONGREGATION POINT AT DAM SEEPAGE DRAIN.

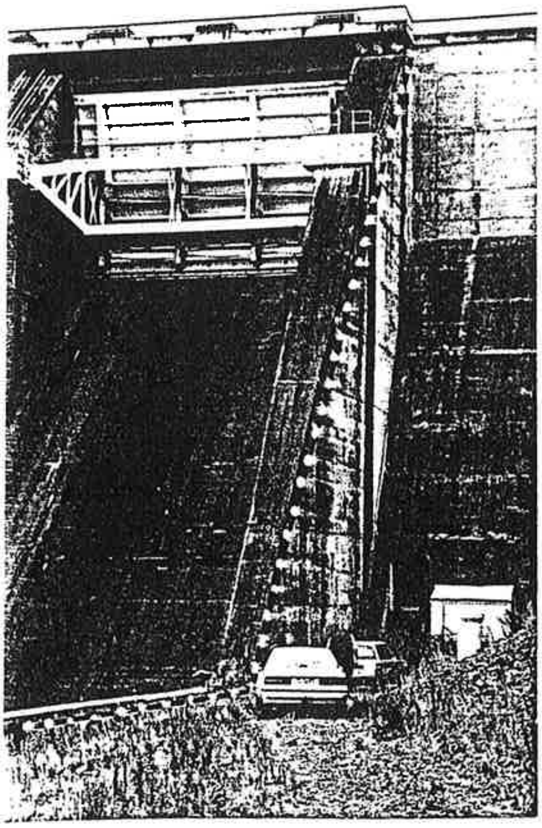


FIG 13 ROUTE FOR OPTION 3. ALONG BASE OF WINGWALL EXTENSION IN FOREGROUND AND UP LEFT SPILLWAY WING WALL.

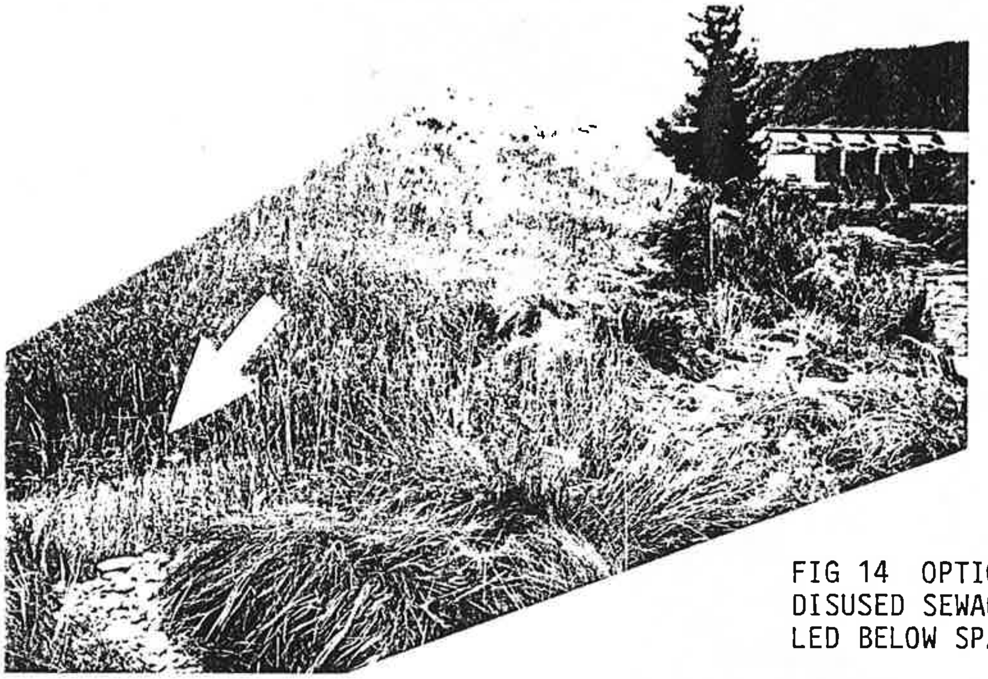


FIG 14 OPTION 4 AVIEMORE.
DISUSED SEWAGE CHANNEL PRESENTLY
LED BELOW SPAWNING CHANNEL

FIG 15 SLOPING PLAIN LEADING TO SEWAGE TREATMENT PONDS.
THIS DRAIN WOULD BE NO OBSTACLE TO ELVERS.

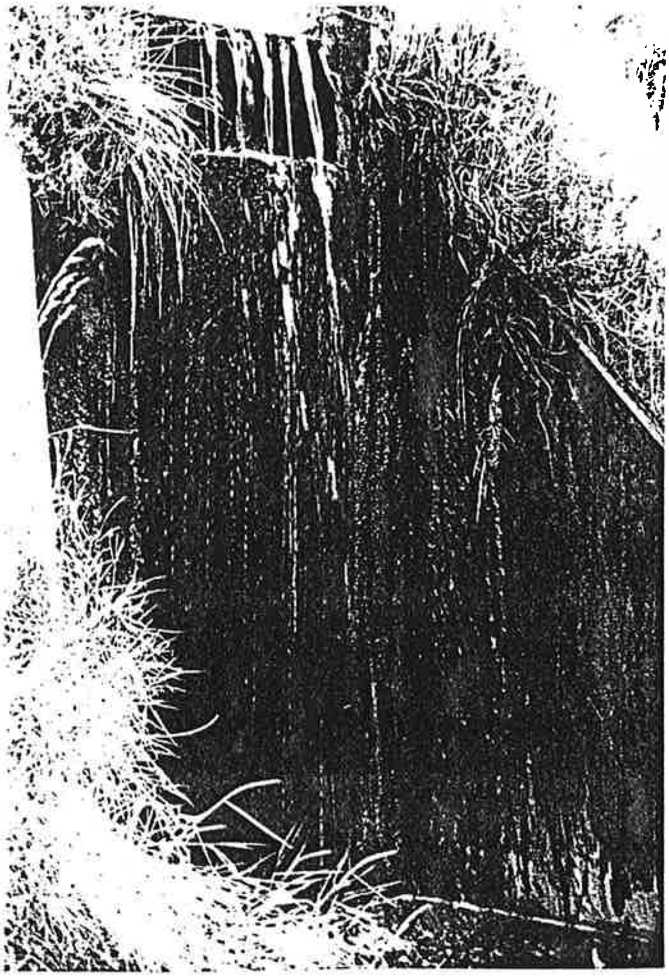


FIG 16 VERTICAL DROP
BELOW EACH TREATMENT
POND, SOME PROVISION FOR
ELVERS WOULD BE NECESSARY
- PROBABLY ONLY NEED
INFILLING WITH RUBBLE

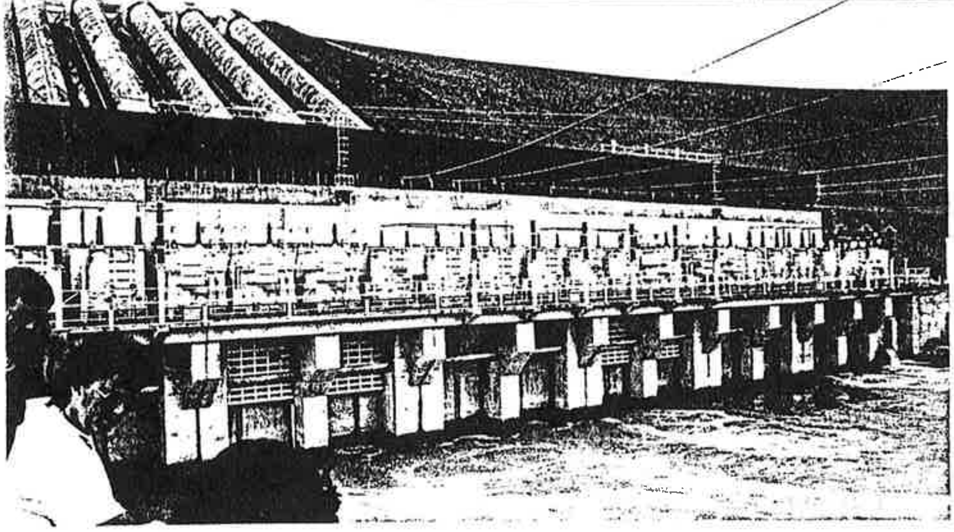


FIG 17 BENMORE DAM POWERHOUSE GENERATOR COOLING WATER DISCHARGE IN FAR RIGHT CORNER.

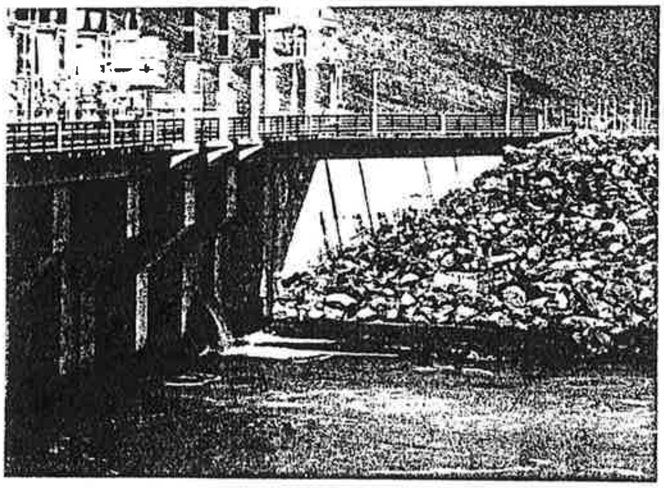


FIG 18 GENERATOR COOLING WATER DISCHARGE AND CONCRETE APRON

FIG 19 TOP VIEW OF CONCRETE APRON. ELVERS ATTEMPT TO CLIMB ALONG BANKSIDE EDGE OF THE APRON. ELVER PASS ENTRANCE WOULD BE SITED AT BANKSIDE EDGE APPROX 1 M FROM WHERE THE APRON IS DEFLECTED DOWN

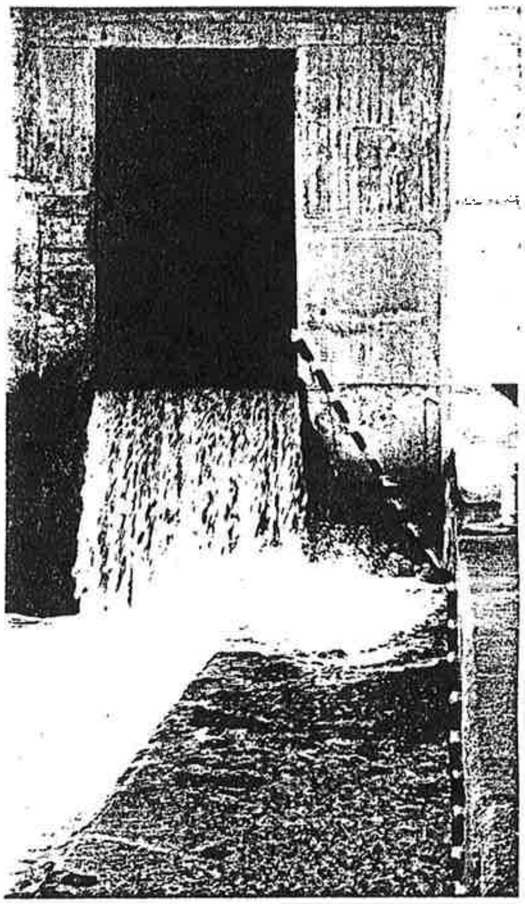
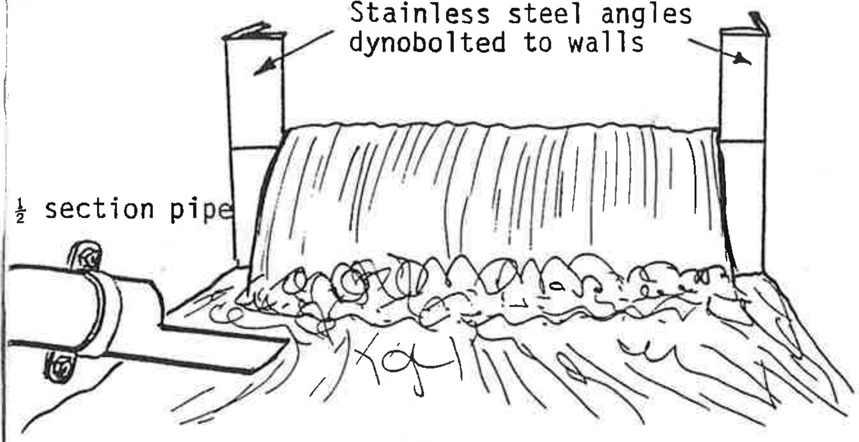
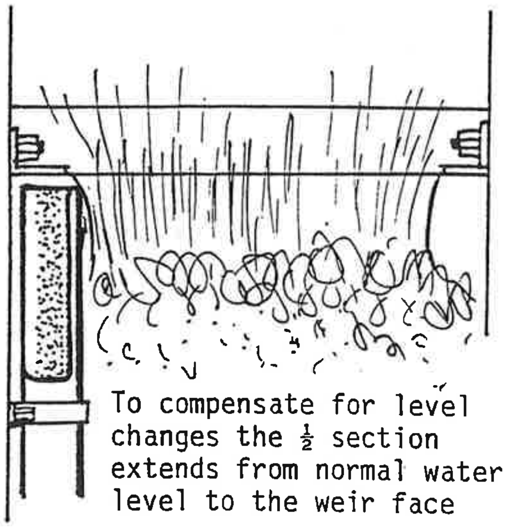
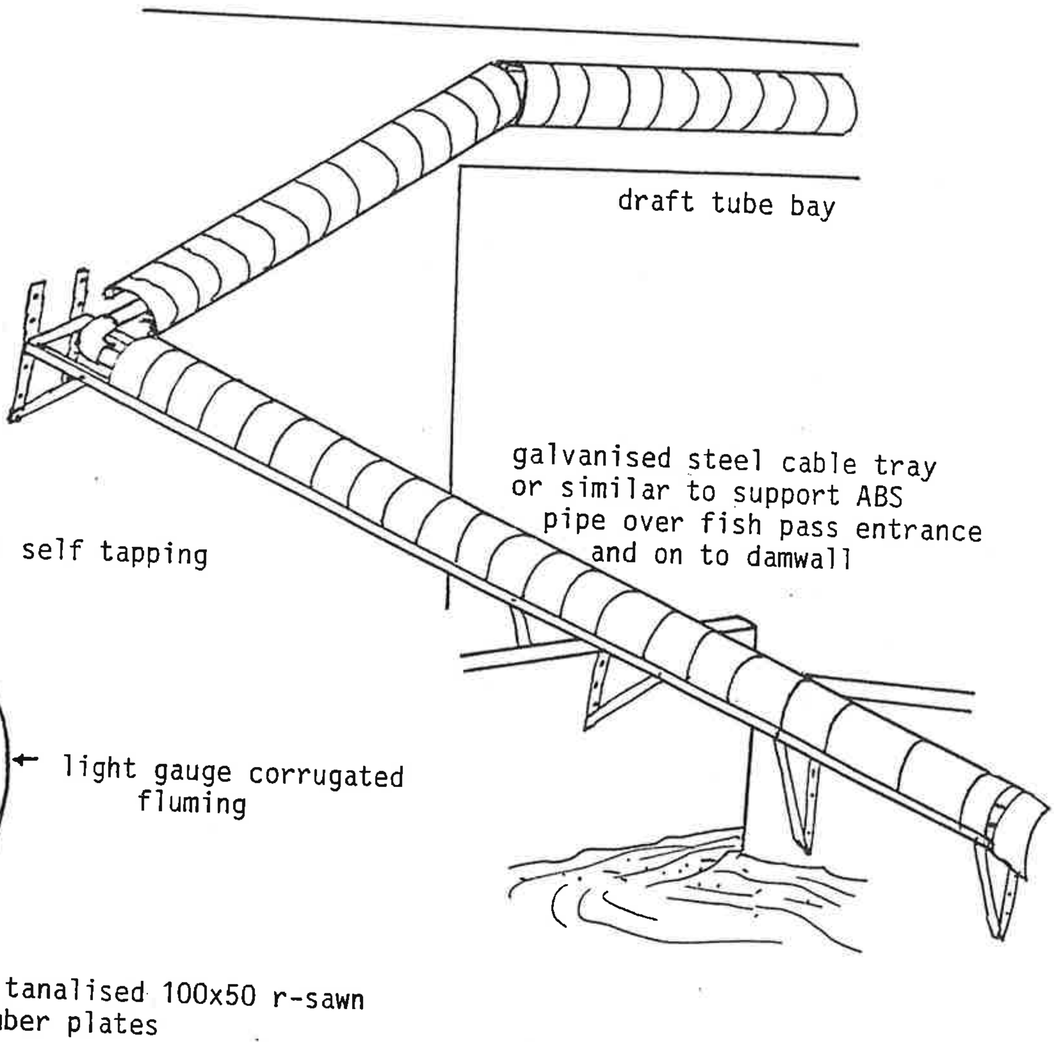


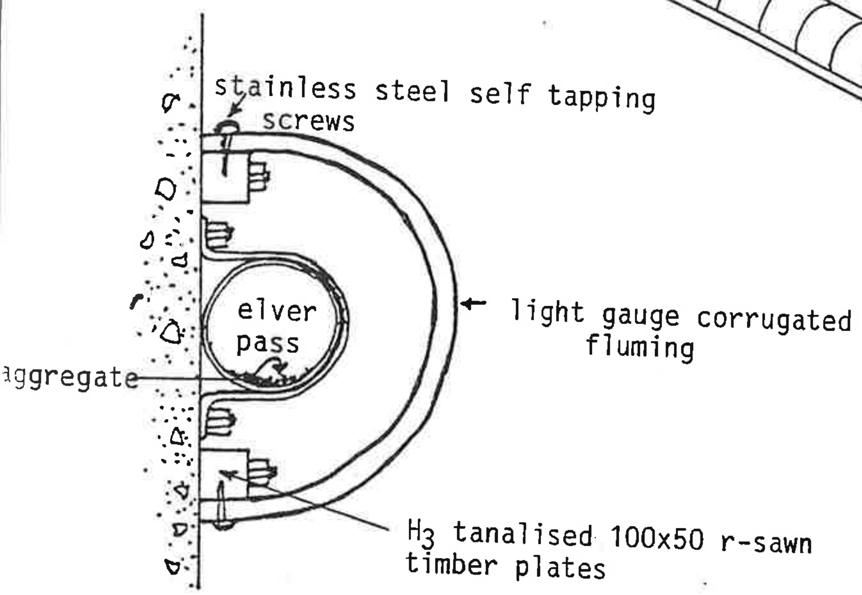
FIG 20 GENERATOR COOLING WATER DISCHARGE. ELVER PASS WOULD BE ATTACHED TO THE WALL OF THIS TUNNEL.



ENTRANCE



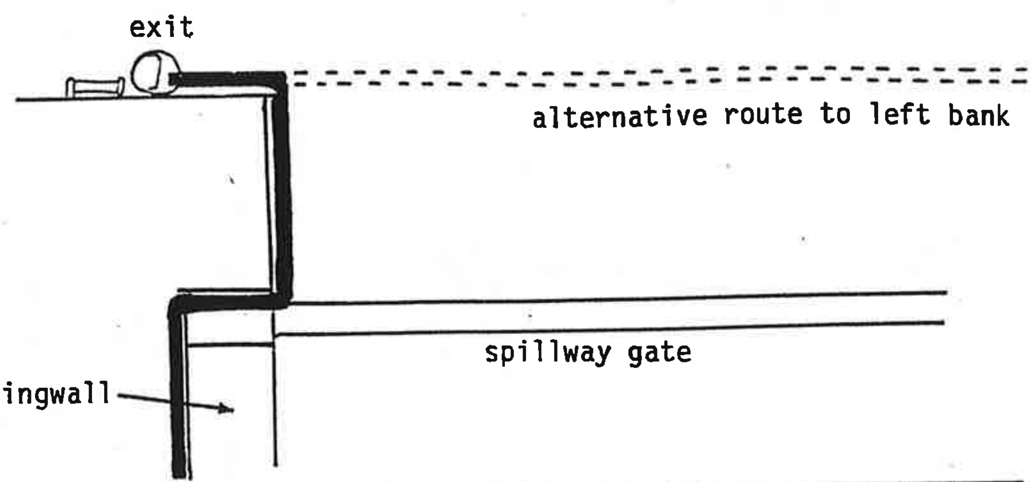




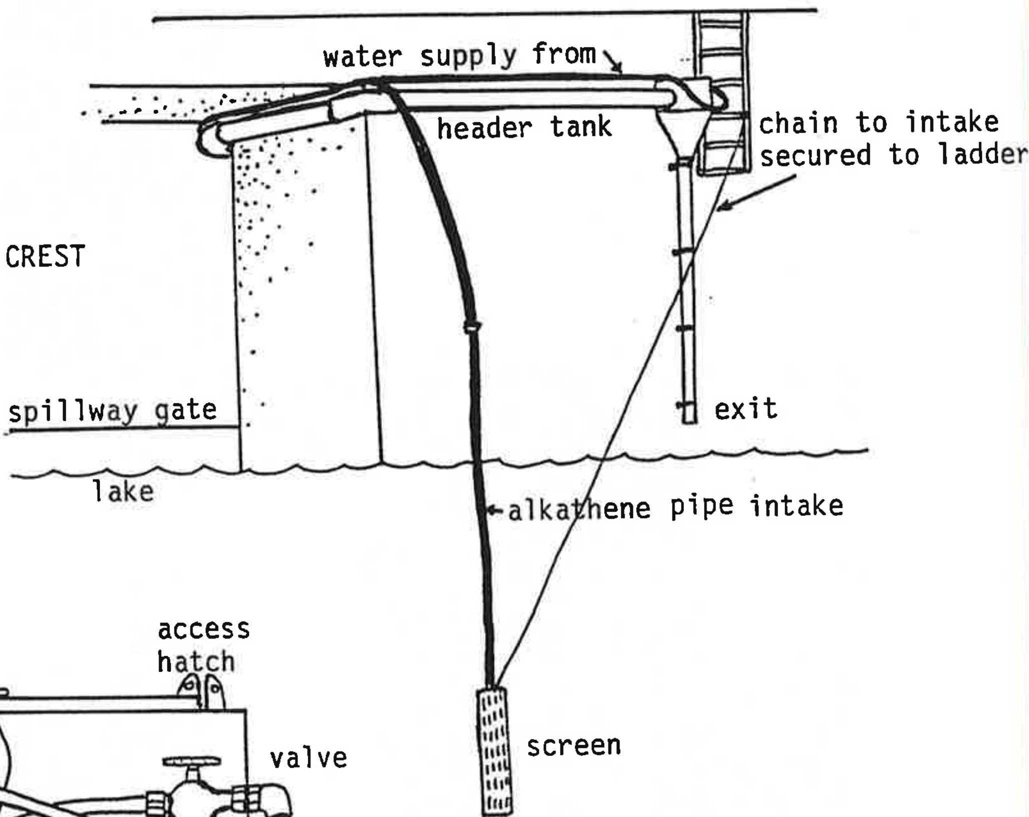
COVER (APPLIES TO ALL SITES FOR EXPOSED SECTIONS)

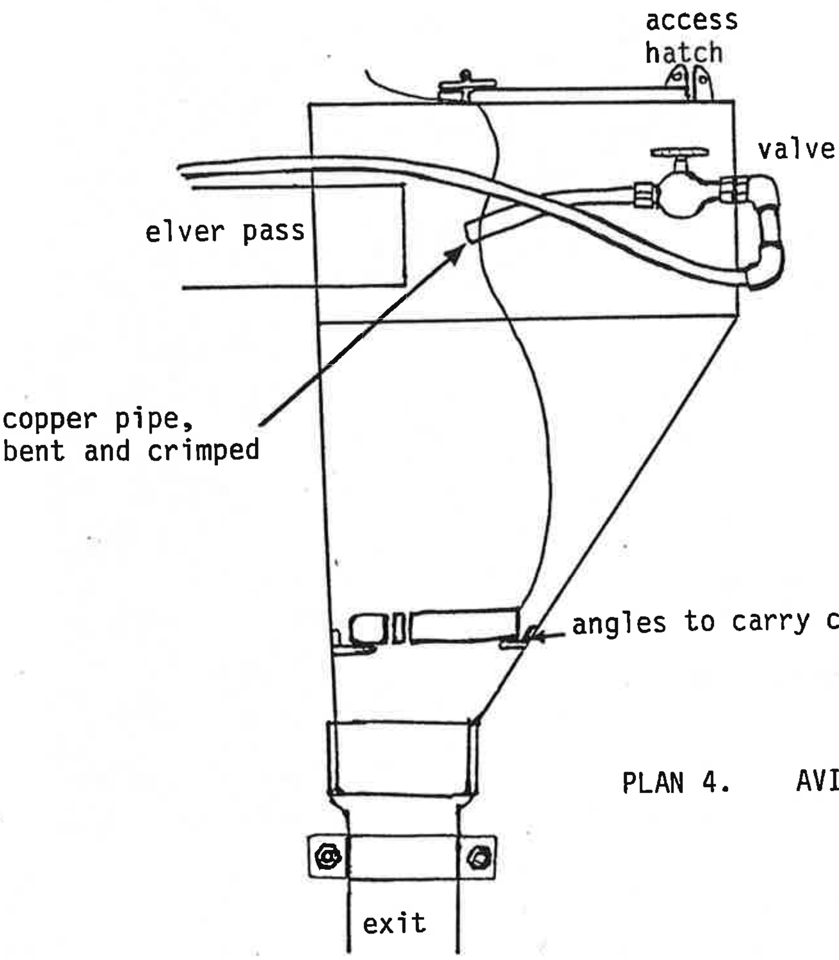
PLAN 3 AVIEMORE DAM ELVER PASS DETAILS

ROUTE AROUND SPILLWAY GATES



ROUTE BENEATH DAM CREST





FLUSHING POINT FOR EXIT

PLAN 4. AVIEMORE DAM ELVER PASS DETAILS

From this point there are two options:

1. Connect to a pipe which leads to a stormwater sump beside the penstock slope. But if the pass cannot be kept separate from the stormwater flow there is potential to damage the elver pass. Floodflows, debris or accidental spills of oil or chemicals are all potential threats.

2. Lead a brush type pass straight up the wall of the stilling chamber. An aggregate coated section would then lead around the intersection of the concrete and the rock face, to the back of the debris collector on the spillway slope.

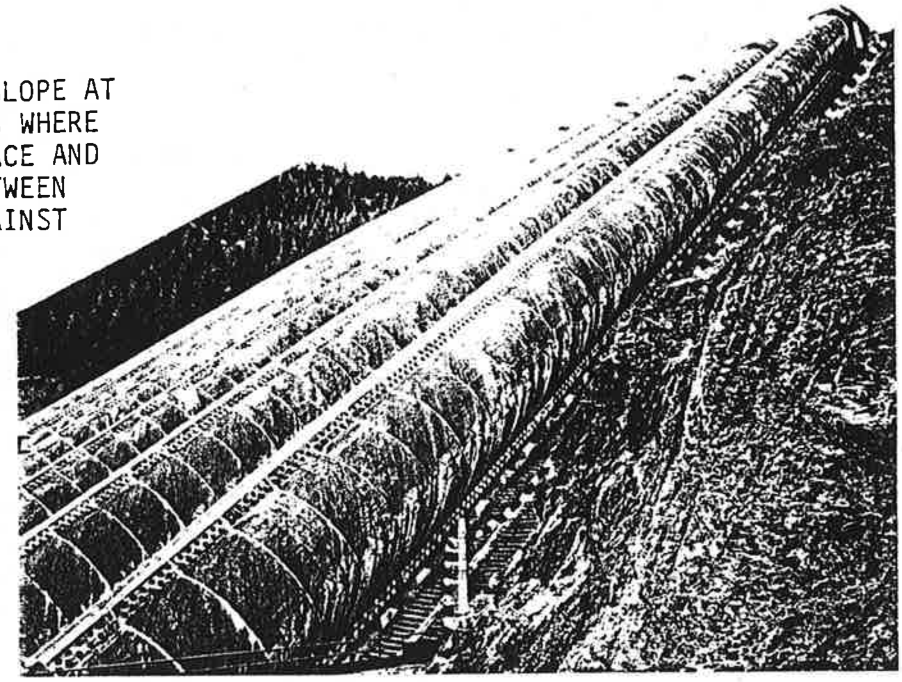
Again there are two alternative routes up the penstock slope. One is to fix aggregate coated pipe to the strip of concrete between the two flights of stairs (Fig 21). The other option is to attach the pipe to the sides of the penstock foundations.

Once at the top of the penstock slope, one option is to lead the pipe through a hole cut in the walls of the hydraulic gate lifting room and exit in the corner of the stop log storage room (Fig 22). The pipe can then run along the underside of the footpath lip to exit beside the rocky area where the earth dam begins. An alternative is to lead the pipe up the rock face on the lefthand side of the horizontal penstock section (Plan 5). The pipe can then simply angle around the downstream side of the observer platform and run across the ground to the concrete wall of the dam.

From here, the pipe is attached to the wall, rising to meet the top corner of the junction of the concrete and earth dams. Just beneath the road surface at the back of the concrete dam, a 300 mm dia liner pipe could be inserted to carry the elver pass through to the lake. From the other side of the road the pass can return along the underside of the footpath lip to an exit beside where the rocks of the earth dam become permanently submerged (Fig 23).

Power is available on the dam top, there are convenient cables powering the dam lighting system. The header tank could be sited in the hydraulic gate lifting room or on top of the dam. Screening of the pump intake could be improved by setting the pump lines and intake point within the outer layer of rocks of the earth dam.

FIG 21 ROUTE UP PENSTOCK SLOPE AT BENMORE. ELVER PASS STARTS WHERE HANDRAIL INTERSECTS ROCK FACE AND COULD GO UP CLEAR SPACE BETWEEN THE STEPS OR COULD REST AGAINST THE PENSTOCK SUPPORTS.



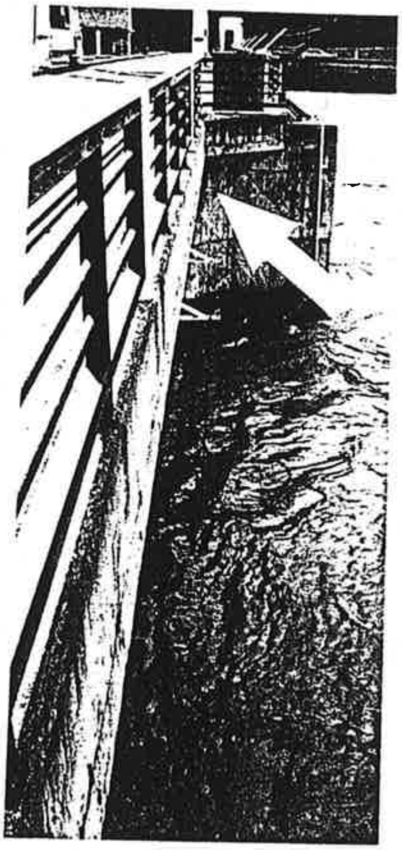
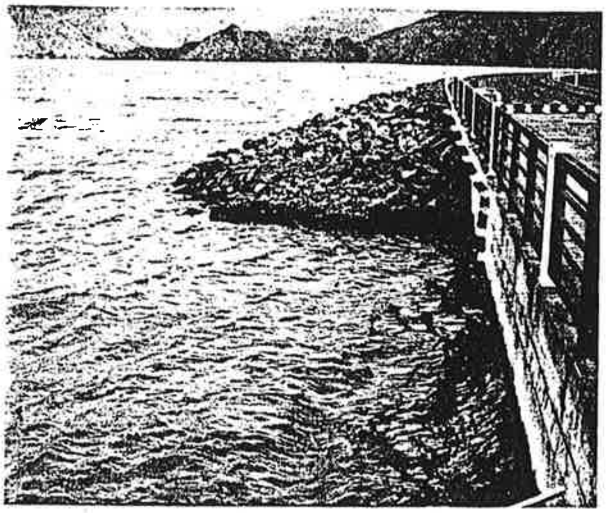
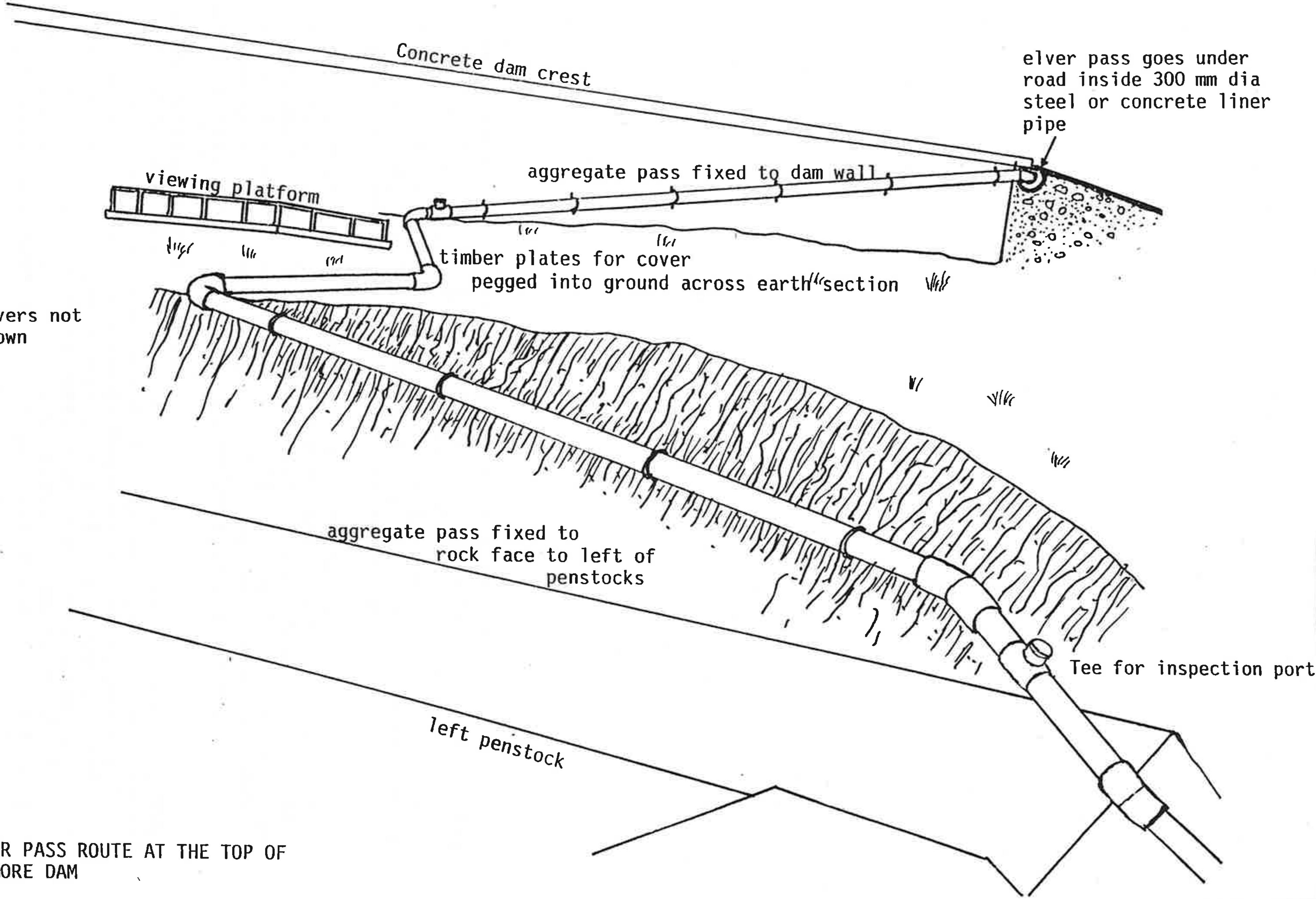


FIG 22 ANGLED FACE IS POINT WHERE A PIPE COULD BE LED FROM THE STOPLOG STORAGE ROOM. THE PIPE WOULD THEN BE ATTACHED TO THE UNDERSIDE OF THE FOOTPATH UP TO THE EXIT POINT.

FIG 23. PIPE COULD BE LED UNDER ROAD AT THE JUNCTION OF THE CONCRETE AND THE TARSEAL. THE EXIT POINT WOULD BE BESIDE THE ROCKS SURFACING THE EARTH DAM.

- THE PUMP INTAKE COULD ALSO BE PROTECTED BY THESE ROCKS.





note: covers not shown

PLAN 5 ELVER PASS ROUTE AT THE TOP OF BENMORE DAM

CONCLUSIONS

It is definitely possible to build elver passes over the Waitaki Dams. The final choice of options depends upon weighing up a whole range of factors. An ideal elver pass system would be one which collected all the elvers from either side of the draft tube discharge and which then discharged elvers against the bank, where they can quickly hide from predators. In practice, we will have to do the best we can with dams that were neither designed or built with elvers in mind.

Reality will force a series of compromises. Seemingly insignificant decisions at the design and construction stages will have a major impact upon the native fish populations of the middle Waitaki System for a very long time to come. It has been my experience that there is plenty of room between concept, plan and construction for all manner of mistakes to creep in.

I strongly recommend Electricorp retain the services of a fisheries biologist, interested in eels, throughout this project. He/she/it will be needed to help with the engineering choices. Even more importantly, the biologist will provide the construction team with guidance on the peculiar requirements and strange ways of our native freshwater fishes.

APPENDIX

SPECIALISED ITEMS

Elver Brushes: These are made by Artel Products, Levin (ph 069-82-169) Contact: Mr Fowler.

Brush Type: 1000x130, Bristle Type: Nylon, Polystar 020.
Wire: (recommended) low tensile 12 gauge stainless steel. Three month delay for importation of wire after placing order.
Cost: $9.17 /brush, 3 brushes needed /m of pipe.
If galvanised wire used $5.64 /brush.

Aggregate Coated Pipe: Made up onsite using 3 m lengths of 150 mm dia waste grade ABS plastic pipe.

Method:

Pour liquid solvent based ABS cement down a length of pipe to form a continuous tract of cement 100 mm wide. Rotate 180^0 and pour dry river stone aggregate down the pipe. (Aggregate grade: 10 mm dia maximum sized stones down to coarse sand). Quickly vibrate until aggregate is uniformly spread along the bottom of the pipe. Flip back 180^0 so that aggregate is tipped onto cement and leave to dry. Bonding of aggregate is completed by pouring a second lot of cement down the pipe, over the aggregate. A fine coating of sand poured down the margins of the coarse aggregate is added at this stage. It is at the edges of the aggregate, on the margins of the sand and the pipe wall, that elvers and native fish climb. Bigger fishes such as lampreys will obviously use the whole wetted surface

Note: Experience at Matahina to date indicates the elvers are not attracted to concrete-lined steel pipe. The contrast between their use of aggregate coated pipe and the concrete-lined pipe is obvious. Therefore I have reservations about using concrete lined pipe for elverpass construction.